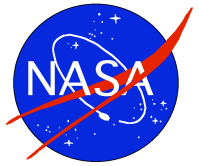




## GLAST Monthly PSR – April 7, 2004

# Systems Engineering

*N. Rioux*


# RFA Status

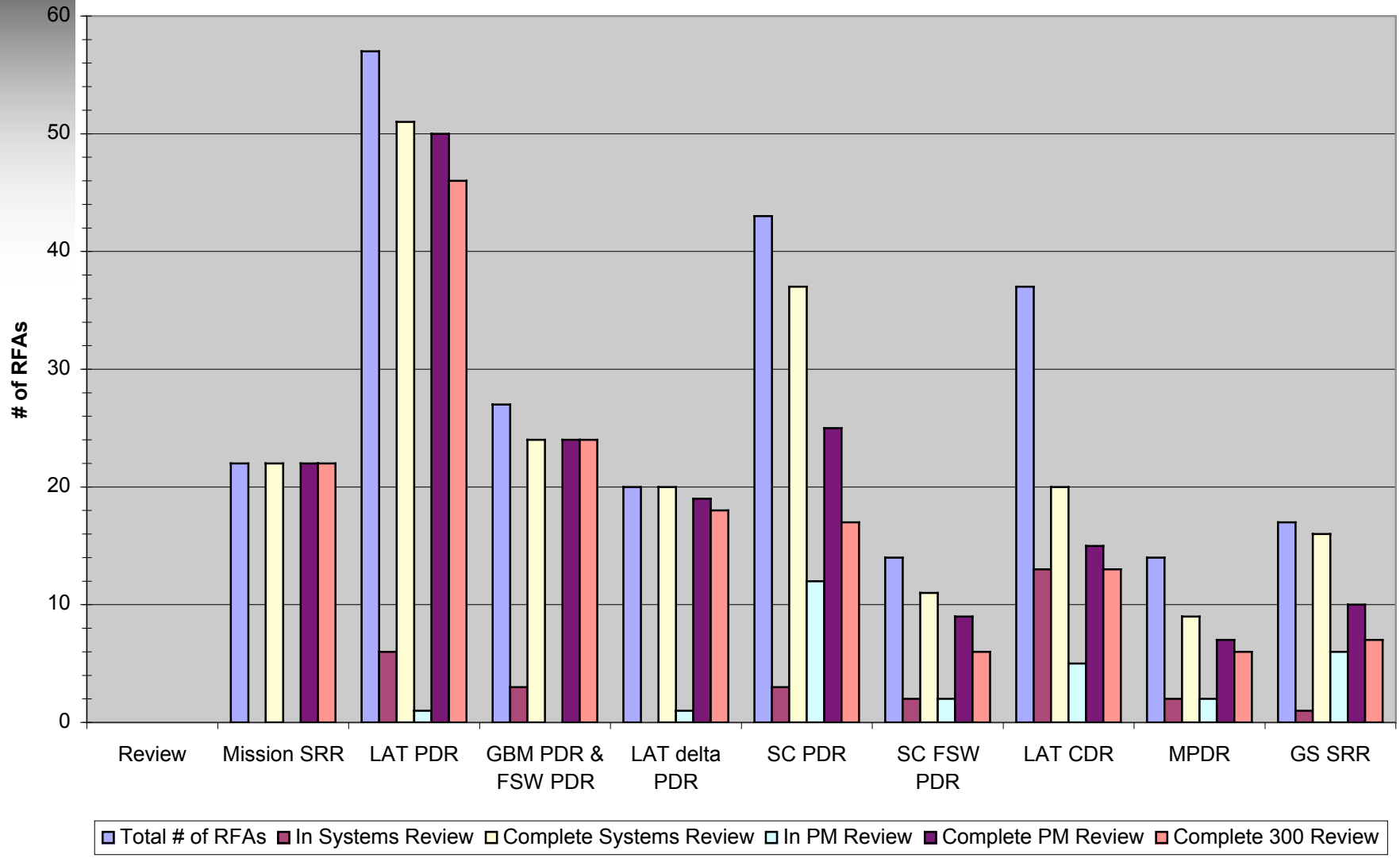
- ***Systems approved 22 RFA responses last month. There are still 30 responses in the Systems review process. Continued to work with Spectrum and SLAC to revise/edit comments per Project comments.***
- ***PM approved 12 RFA responses last month. Working to update responses based on PM comments to other 10 RFAs that were sent last month.***
- ***Received Originator approval for 28 RFA responses last month. Provided 5 updated responses to Originators based on their comments. 4 have been approved.***
- ***We are only waiting for 11 more RFA responses:***
  - *3 from SC PDR (all GPO): Use of Excess ELV Mass Margin, Low Obs. Mass Margin, & Early Prop Test*
  - *1 from SC FSW PDR (GPO): Consider 2nd Hot Bench*
  - *4 from LAT CDR*
  - *3 from MPDR (all GPO): Open ICD Issues, RAD750 Upsets, LAT Choke Points*
- ***In addition to needing above responses, we need to resolve PRU Lambda Converters, Packaging/Manufacturing, and Over Current Protection RFAs prior to SC CDR & 8 Cmds/sec, FSW Formal Qualification, and Simulink model deliveries prior to SC FSW CDR.***


# RFA Summary (Code 300 & SC Peer Reviews)

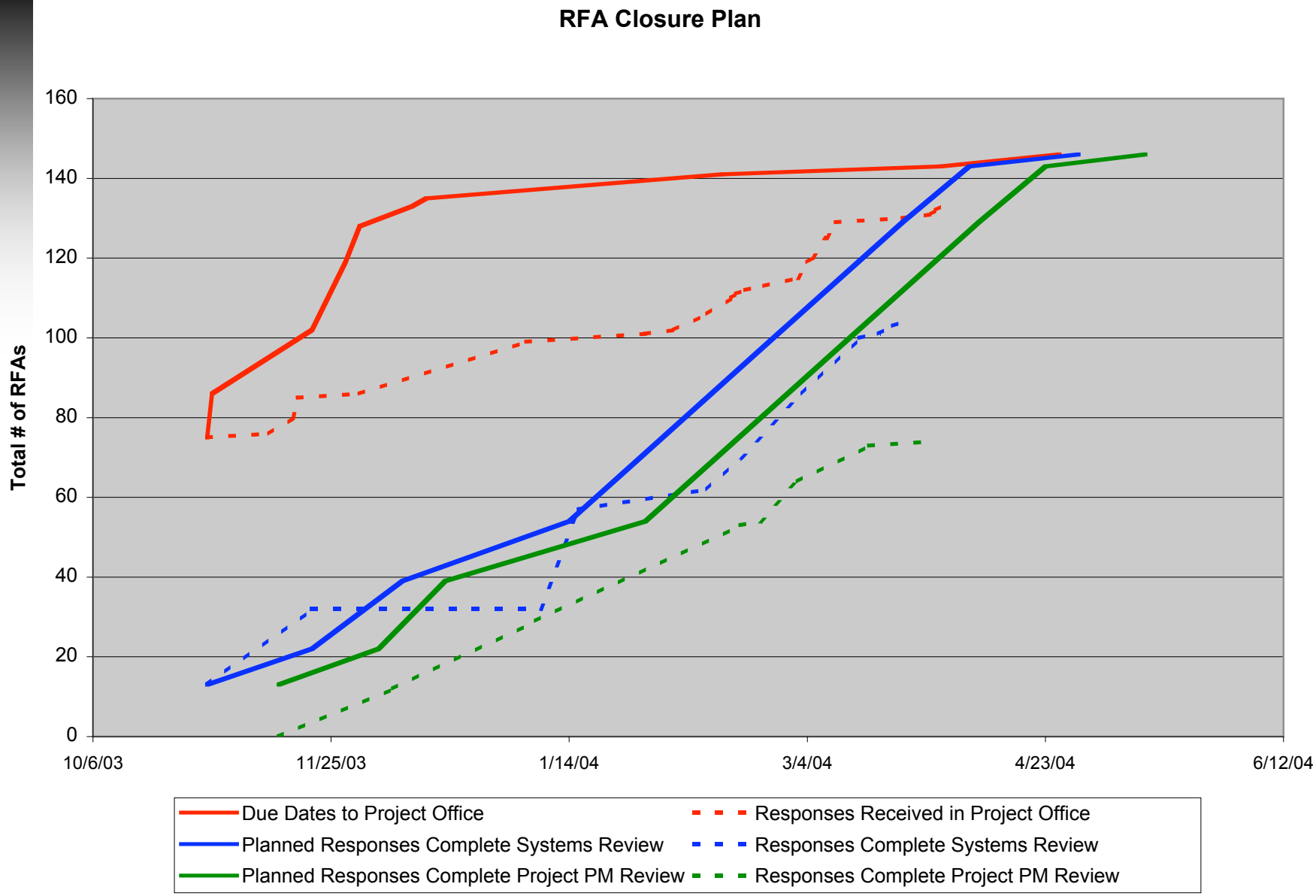
| Review | Total # of RFAs | Systems Review Status | | Project Review Status | | Code 300 Status | Notes |
|---|---|---|---|---|---|---|---|
| | | In Review | Complete | In Review | Complete | # Closed | |
| Mission SRR | 22 | | 22 | | 22 | 22 | All Closed |
| LAT PDR | 57 | 6 | 51 | 1 | 50 | 46 | 11 Open |
| GBM PDR & FSW PDR | 27 | 3 | 24 | | 24 | 24 | 3 Open, 1 Withdrawn |
| LAT delta PDR | 20 | | 20 | 1 | 19 | 18 | 2 Open |
| SC PDR | 43 | 3 | 37 | 12 | 25 | 17 | 26 Open |
| SC FSW PDR | 14 | 2 | 11 | 2 | 9 | 6 | 8 Open |
| LAT CDR | 37 | 13 | 20 | 5 | 15 | 13 | 24 Open |
| MPDR | 14 | 2 | 9 | 2 | 7 | 6 | 8 Open |
| GS SRR | 17 | 1 | 16 | 6 | 10 | 7 | 10 Open |
| **Totals** | 251 | 30 | 210 | 29 | 181 | 159 | |

| Review | Total # of RFAs | Total # of Recomm | Project Review Status | | Originator Status # Closed | Notes |
|---|---|---|---|---|---|---|
| | | | In Review | Complete | | |
| Systems | 12 | 9 | | | | |
| I&T | 14 | 1 | | | | |
| Structural Design | 5 | 2 | | | | |
| Thermal | 6 | 6 | | | | |
| Mechanisms | 2 | 3 | | | | |
| C&DH | 14 | 3 | | | | |
| COMM | 22 | 2 | | | | |
| EPS | 20 | 3 | | | | |
| GNC | 6 | 4 | | | | |
| Fault Management | 15 | 6 | | | | |
| Structural Analysis | | | | | | |
| **Totals** | 116 | 39 | | | | |

# RFA Response Summary Chart



# RFA Closure Plan vs. Actuals




# GLAST Project CCR Status

- ***1 CCB held in March (via telecon)***
  - *7 CCRs reviewed at the CCB, 5 approved, 2 deferred*
    - *Approved CDRL 1, GPS Antenna Thermal Control, LAT Thermal Model Size, LAT MOI, Update LAT Science Data Rate*
    - *2 Deferred due to updates (Addition of LAPSS and Update to LAT-SC Drill Template and Flexures). Both have been updated and rereleased in the system*
  - *1 CCR approved out of board*
    - *433-0230, Rev B to MOC SOW*
- ***Currently there are 15 CCRs in the System***
  - *Removal of ISM, Update to GFE list, Reallocation of Burst Alert Latency, LAT DC Voltage Tolerance from 42 V to 40 V, Remove ISM, Add Ku levels to EMI, Update Delivery Date for LAT-SC Drill Template and Flexures, LAPSS*
  - *SLAC has stated that the Project ITAR document is now in their legal review*
  - *SSMAP still in Code 300 Review*
  - *Spectrum did not hold their ERB during Peer Reviews, awaiting their response to numerous CCRs*


# Accomplishments

- ***Organized and Coordinated SC CDR Peer Reviews***
  - *12 reviews and an MPSR*
  - *Thank you to all the supporting project engineers*
  - *Rollup of RFAs into Major, Significant Issues Underway*
- ***Mission Robustness Special Study under review with Spectrum and GSFC contracts***
  - *Intended to add flexibility to initiation of special studies*
  - *Augmentation of Diagnostics & Troubleshooting Capability*
    - *Enhanced boot process diagnostics capability*
    - *Capture of processor data in RAM, SSR or UDL*
    - *Enhanced IEM diagnostics*
  - *Command Authentication*
  - *Augmented Fault Detection, Isolation and Recovery.*
- ***Review of CDRL 29 comments with Spectrum in progress***
- ***Coordinated with DPM and GSFC engineering for delivery of TURFTS rack to Spectrum***


# Observatory STOP Analysis Status

- ***Cycle 2: Unit Thermal Gradient & Static Thermal Case Analysis w/ interim LAT CDR models***
  - *Results to be provided on 04/06/04*

- ***Cycle 3: Observatory-Level STOP Analysis using final CDR models***
  - *Transient case analysis using worst-case on-orbit thermal cases identified (and C2 results)*
  - *LAT Models*
    - *03/02/04 SLAC provided LAT FEM v10.08, v10.08S and TMM v5.0 to GPO/Swales*
    - *03/19/04 Swales completed review of LAT FEM v10.08S and communicated concerns/feedback to SLAC*
    - *03/31/04 Swales created LAT FEM v10.08S2 from v10.08 and reviewed updated v10.08S from SLAC*
    - *TBD SLAC performing thermal/mechanical distortion analysis using their v10.08S model*
  - *SC Models*
    - *03/17/04 SAI performed FEM updates to accommodate flexure redesign and GBM mass increase*
    - *04/04/04 SAI resolved TMM to FEM mapping issues*
    - *TBD SAI to provide TMM, FEM and model mapping to GPO/Swales*

- ***Cycle 4: Observatory-Level STOP Analysis using T/V-correlated LAT models***
- ***Cycle 5: Observatory-Level STOP Analysis using T/V-correlated observatory models***


# Mass Budget

| | Mass (kg) | | | | |
|---|---|---|---|---|---|
| | Allocation | Estimate | Margin | % | Delta |
| Dry SC | 1151 | 933 | 218 | 23 | 3 |
| SC including propellant | 1512 | 1291 | 221 | 17 | 1 |
| LAT | 3000 | 2756 | 244 | 9 | 0 |
| GBM | 115 | 101 | 14 | 13 | 0 |
| Observatory mass | 4627 | 4149 | 479 | **12** | 10 |

**GBM thermal solution mass lien -**

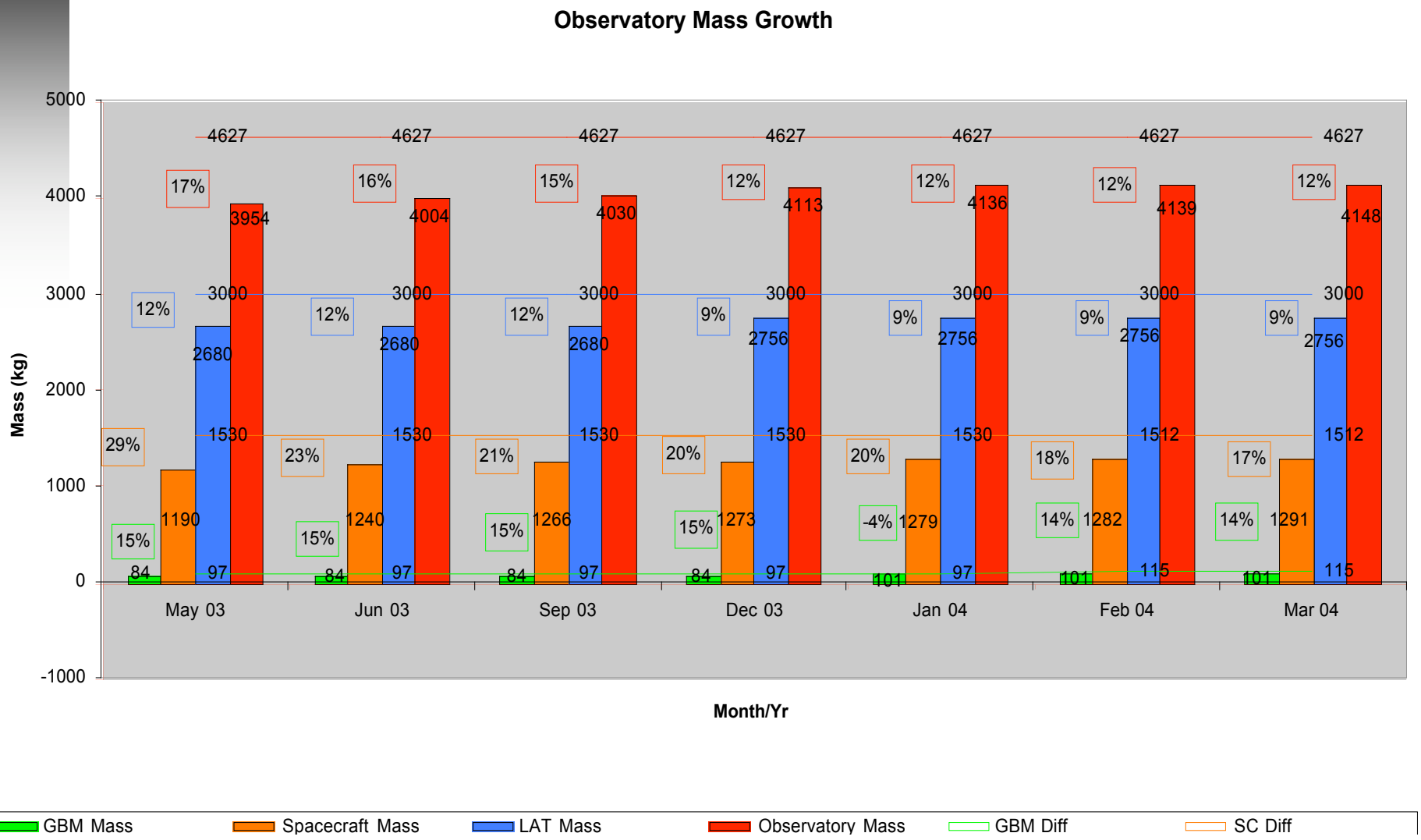
**Cluster radiator solution: 4 to 8 kg (.75 kg for 3 NaIs X 4) + (.5kg X 2GBOs)**
**Teflon tape: No mass impact (roughly 100% more heater power than cluster radiator solution)**

**Delta II Heavy throw weight to 575 km with cg at 1.37 m = 4627 kg**

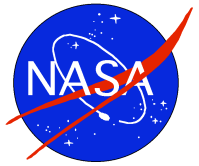
**70% of LAT mass estimate is measured**

**LAT is carrying 30% margin on the unmeasured LAT mass of 827 kg**

# Observatory Mass Growth




# Power Budget




**Orbit Average Power (Watts)**

| | Allocation | Estimate | Margin | % | Margin Delta |
|---|---|---|---|---|---|
| **Spacecraft** | 985 | 752 | 233 | 31.0 | - 4 |
| **LAT** | 650 | 566 | 84 | 14.9 | 0 |
| **GBM** | 65 | 57 | 8 | 14.0 | 0 |
| **Observatory total** | 1700 | 1375 | 326 | **23.7** | -4 |

**GBM thermal solution power lien (analysis incomplete – relative comparison of solutions) -**

**Cluster radiator solution: all elements at worst case (to be rationalized) – 50 W**

**Teflon tape: all elements at worst case (to be rationalized) – 120 W**

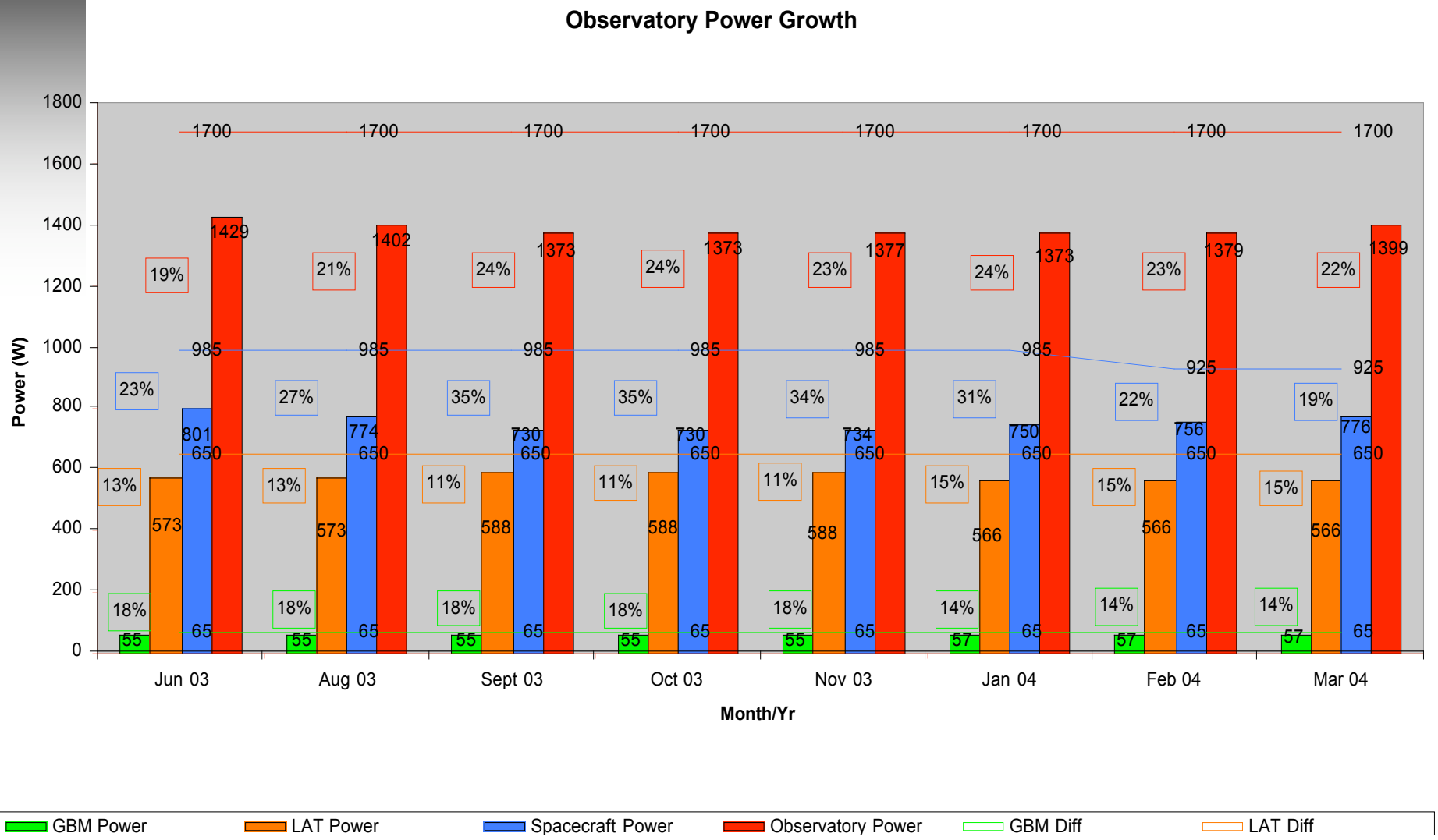
LAT Orbit average survival power: 278 W

Regulated VCHP power 58 W + Unregulated Passive Survival Power 220 W

Estimates do not reflect transition into or out of survival mode, only steady state orbit average.

72% of LAT science mode power (406 W) is categorized as measured.
LAT is carrying 52% margin on unmeasured power of 160 W.

# Observatory Power Growth




# Observatory Thermal Metrics

| | Spacecraft (Pre CDR Peer Rev) | LAT (CDR) | GBM (Post-CDR) |
|---|---|---|---|
| **Number of Component Temp. Limits** | 52 | 13 | 4 |
| **Number of Component Temp. Exceedances** | 0 | 0 | tbd |
| **Number of Component Temp. Margin Exceedances** | 3 hot, 1 cold | 0 | tbd |
| **Number of dT/dt Limits** | 1 (GPS ant) | 1 | 1 |
| **Number of dT/dt Exceedances** | 0 | 0 | tbd |
| **Number of dT/dx, dT/dy, dT/dz Limits** | 2 (Opt Bench, Battery) | 0 | 0 |
| **Number of dT/dx, dT/dy, dT/dz Exceedances** | 0 | 0 | 0 |
| | | | |
| **Op Orbit Average Heater Pow Margin (vs. Allocation)** | 4% | 63% | tbd |
| **Surv Orbit Average Heater Pow Margin (vs. Allocation)** | 19% | 28% | tbd |
| | | | |
| **Radiator Area Margin (vs. Available)** | 11% | 0% | tbd |

**Definitions:**

**Temperature Margin Philosophy: Predictions demonstrate +/- 5C against Flight Allowable Temperature (FAT) Limits**
**Note: For heater controlled areas 5C margin is waived.**

**Temperature Exceedance: Temperature Predict > Flight Allowable Temperature Limits (On-Orbit Design Limits)**
**Temperature Margin Exceedance: Temperature Flight Allowable Limit - Temperature Predict < 5C**

**Op Heater Power Margin (Orbit Average): (Allocation-Predict)/Allocation *100**
**Surv Heater Power Margin (Orbit Average): (Allocation-Predict)/Allocation * 100**
**Note: Heaters are sized to maintain a 30% control authority margin at selected minimum conditions.**

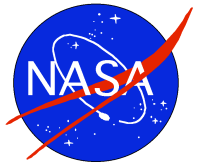
**Radiator Area Margin: (Available-Utilized)/Available * 100**

No Changes since last month

**For Hot: They are batteries, GBM PSB (Goal would be 45C, predict = 49C) and Reaction Wheel(s) (Goal would be 45C, predict = 47C). None of these can be easily adjusted to meet the margin goal given existing radiator area resources.**

For Cold: It is only the Ku-band Antenna mechanism and only because I have not modeled the heater correctly since the change to Ku - it should easily go away


# Priority 1 Issues
## Outcome Could Impact Baseline




**•Structural analysis (CLA, STOP, stress and lifting)**

**•EPS Issues:**

- **EPS undervoltage issue (RFA)**
- **EPS detailed energy balance calculations (RFA)**
- **PRU overvoltage protection (aka 42V requirement) (RFA)**
- **Transorb lifetime (RFA) possible PRU re-design for a crowbar and simultaneous solution of 42V problem**
- **Fusing – LAT polyfuse implementation**

**Close end-to-end fusing analysis by *mission* CDR**

**• FMEA, FTA, detailed reliability analysis**

**CDRL due Friday April 9th**

**•EMI/EMC design, flowdown and compliance status**

**Fred must approve RFAs before SC CDR**

**• S-band antenna study & percent coverage (RFA)**


# Priority 1 Issues
## Outcome Could Impact Baseline

- **Solar Array Kapton:**

  - **Cut cost of 5 mil qual program**

    **Review basis for Spectrum ROM**

  - **Examine impacts of higher intial orbit than 575 km**

    **Kapton erosion mitigation**

    **Science impacts**

      **Analysis underway for 1 mil residual at 5 and 10 year orbit life**

      **Issues**

        **Extra fuel for de-orbit from higher altitude**

        **Qual observatory for new environment**

  - **Re-boost**

    **Exhaust boost plume impingement**

    **Ops impacts**


# Priority 2 Issues
## Must be Completed for SC CDR

- **MAR flowdown status**

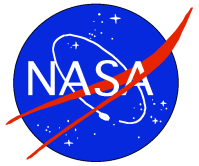
- **Analysis and documentation of requirements**
  - **flowdown to PFSs, SOWs and purchase orders**

- **GNC stability analysis (RFA)**
  - **Frequency domain – need it for all control modes and loops**
  - **Must be done by SC CDR**

- **SC CDR Peer Review RFAs**
  - **GPO Systems Executive Co-chairs responsible for status & closure**
  - **Action – rank and classify RFAs**

- **Observatory mass capability beyond the baseline**
  - **Need assessments from:**
    - **SMS**
    - **GNC**
    - **Propulsion**
- **RFA closure process**
- **Mass margin including ballast**


# Priority 2 Issues
## Must be Completed for SC CDR




- **TDRSS scheduling impacts to SC design for SN return links after re-points**

- **Instrument verification matrices delivered to SAI**

- **Fault management issues**
  - **ARM Single Point Failure - can fail in CPU reset state (RFA)**
- **CCRs**
  - **Create ROM for Integrating Instrument Interface Simulators With MTS**
  - **Change to AO Specs**
  - **Update GFE List**
  - **EMI requirements for Ku band**
  - **SRD**

- **Burst Alert latency estimates – square w/ Spectrum**

- **Re-entry Peer Review**

- **Risk Management**
  - **Ku band failure**

- **Close CDRL 29 pre-CDR review cycle**

- **Plan and format for CDR dry runs**
  - **Issue closures**
  - **Presentation rehearsal**


# Near-term Schedule


| | |
|---|---|
| *Moog APM CDR (w/ SADA)* | *April 13* |
| *Structures (Analysis) Peer Review* | *April 14* |
| *FSW Peer Review* | *April 15-16* |
| *SC CDR Dry Run* | *Week of April 19* |
| *PRU Roadshow* | *May TBD* |
| *SC CDR* | *Week of May 24* |
| *Ku Band TIM #2 (~CDR)* | *June 8* |


## APRIL

| S | M | T | W | T | F | S |
|---|---|---|---|---|---|---|
| | | | | 1<br>2 EMI CDRLs Due | 2 | 3 |
| | | | | Final Minutes and Action Items Written Up For Each Peer Review | | |
| 4 | 5 | 6 | 7 | 8 | 9<br>2 CDRLs Due | 10 |
| | | | Review and Sign CDRLs | | | |
| | Final Minutes and Action Items Written Up For Each Peer Review | | | | | |
| 11 | 12 | 13 | 14<br>Structural Analysis Peer Review | 15<br>FSW CDR<br>GLAST PMR | 16<br>FSW CDR<br>CDR Charts Repro. | 17 |
| | CDRL Review and Signature | | | | | |
| 18 | 19<br>GLAST CDR Dry Run<br><br>GLAST MPSR | 20<br>GLAST CDR Dry Run | 21<br>GLAST CDR Dry Run | 22<br>GLAST CDR Dry Run | 23<br>GLAST CDR Dry Run<br>(11) GLAST CDRLs Due | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | |


# Upcoming Meetings

| MAY | | | | | | |
|---|---|---|---|---|---|---|
| S | M | T | W | T | F | S |
| | | | | | | 1 |
| 2 | 3<br>Preparation for GLAST President's Review | 4<br>LAT SIIS Del. (5/4-5/7)<br>GLAST Pres. Review Prep | 5<br>Preparation for GLAST President's Review | 6<br>GLAST President's Review | 7<br>Final CDR Packages Due to Systems Engineering | 8 |
| 9 | 10<br>PM/SE Review of CDR Package | 11<br>Final Chart Updates for Repro | 12 | 13<br>GLAST PMR<br>CDR Chart Package to GPO and Repro | 14 | 15 |
| 16 | 17<br>CDRL Review and Signature | 18 | 19 | 20 | 21 | 22 |
| 23 | 24<br>GLAST CDR | 25<br>GLAST CDR | 26<br>GLAST CDR | 27<br>GLAST CDR<br>(10) CDRLs Due | 28 | 29 |
| 30 | 31 | | | | | |

# BACKUP SLIDE
## TELECOM SUBSYSTEM BLOCK DIAGRAM

CMC Electronics
Ku-Band Transmitters

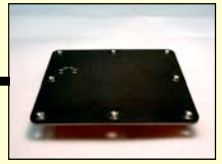
TX

TX

| TX |
|---|
| I & Q Inputs at 20 Mbps – Total Output 80 Msps |

50Ω Load

Moog Type 22 Antenna
Pointing Assembly
(2 Stepper Motors)



Rantec
High Gain
Antenna

Condor Systems
Full Hemispherical
Coverage Antenna

CMC Electronics Solid State
(PIN Diode) Antenna Switches

General Dynamics
S-Band Multi-Mode
Transceivers (MMT)

Ducommun 2PDT Electro-
Mechanical Transfer Switches

TX

BRF

RCV

Diplexer

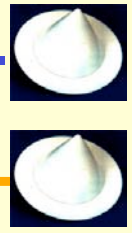
TX

BRF

RCV

Diplexer

+X
Side
of SC



-X
Side
of SC

| Capabilities | | |
|---|---|---|
| **Mode** | **TX** | **RCV** |
| SN MA | 1 k | .25 k |
| SN SA | 8 k | 4 k |
| GN | 2.5 M | 2 k |
| GN | (51 k) | |